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Defense Intelligence Agency XX4
Pentagon
Washington 25, D.C.

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Re: Proposal [redacted]

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It was a pleasure talking with you by telephone on the 8th of October, 1964, and to note your interest in our proposal.

1. This letter is responsive to your request for:

(a) Information regarding the efficiency of the device.
(b) Literature citation.
(c) A smaller budget.

2. (a) A study of the mathematical-physics theory of dipole photo-ion shielding is enclosed. The conclusions from this study are:

A. The device should be efficient.
B. A low level of UV radiation will actuate the device.
C. Ionization by collision, initiated by photo ions would amplify the process.

(b) Literature Citations. We know of no published references which deal with the interaction of dipoles and photo ions in an electric field. However, the book "Photochemistry in the Liquid and Solid States" published by John Wiley & Sons, Inc. in 1960 is a reference which may be useful for suggesting photo ion processes known to be effective.

(c) A revised budget is submitted as Paper No. 3.

STATINTL [redacted] -2- October 9th, 1964

If there are further questions, please contact us promptly.

It is trusted that our amended Proposal is now in order and that we will be favored with advice to soon commence contract negotiations.

With kind regards..

Very sincerely yours,

[redacted]

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Enclosures

Paper No. 2: Dipole Photo-Ion Shielding Theory
Paper No. 3: Revised Cost Analysis

[redacted]

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9 October 64

PROPOSAL NO. 64-801- PAPER NO. 2

DIPOLE - PHOTO-ION SHIELDING THEORY

-by-

[redacted]

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International MKS-A units will be used herein. Values of the general physical constants were recommended by NAS-NRC and are those adopted by the National Bureau of Standards, October 1963.

Assuming a quantum efficiency of 1 determine the photon energy of ultraviolet wavelength 3500Å required to establish or balance an electric field intensity of $E = 100$ kv/cm (10^7 volts/m). This is the order of magnitude of electric field intensity required to align dipoles in times of the order of microseconds.

First determine the electrons per unit area required to establish a field of $E = 100$ kv/cm or (10^7 volts/m), or capable of shielding such a field; for a unit area $A = 1 m^2$, with a dielectric constant for the dipole medium $\cong 2.5$.

The charge in coulombs to establish such a field is:

$$Q = VC \qquad (1)$$

Where, for a capacitor:

Q = charge in coulombs

V = potential difference

C = capacitance

The capacitance is given by:

$$C = \epsilon A/L \quad (2)$$

where

$$\epsilon = \epsilon_o K \quad (3)$$

From (1), (2) and (3):

$$Q/A = V\ \epsilon_o\ K/L \quad (4)$$

where

$$\epsilon_o = 8.854 \times 10^{-12} \text{ farads/m} \quad (5)$$

$$K \cong 2.5 \text{ (MPC)} \quad (6)$$

If E = field strength in volts/m

$$E = V/L \quad (7)$$

$$Q/A = \epsilon_o K\ E \quad (8)$$

On a unit area a charge of Q coulombs is produced by η electrons per unit area (m^2): or by $\eta/2$ electrons on one face of the capacitor, and $\eta/2$ singly charged positive ions on the other face.

$$(Q/A) = \eta\ e \quad (9)$$

where $e = 1.602 \times 10^{-19}$ coulombs/electron (10)

Hence:

$$\eta = (\epsilon_o/e)\ kE \text{ (electrons/m}^2\text{)} \quad (11)$$

$$(\epsilon_o/e) = (8.854 \times 10^{-12}/1.602 \times 10^{-19}) = 5.527 \times 10^7 \quad (12)$$

From (11) and (12):

$$\eta = 5.582 \times 10^7\ k\ E \quad (13)$$

Hence substituting the values of K and E into (13):

$$(\eta/2) = 5.582 \times 10^7 \times 2.5 \times 10^7/2 \tag{14}$$

$(\eta/2) = 6.98 \times 10^{14}$ electrons and singly charged positive ions per m^2. (15)

Next, determine the number of photons to photoionize $(\eta/2)$ molecules per m^2 which will provide $\eta/2$ electrons and $\eta/2$ singly charged positive ions per m^2.

Assuming a quantum efficiency of 1:

There is 1 photoionized molecule per photon, hence there must be 6.98×10^{14} molecules per m^2 photoionized by 6.98×10^{14} photons absorbed in the dipole layer per m^2.

The energy ξ (joules) contained in $\eta/2$ photons is:

$$\xi = (\eta/2)\, h\, \nu \tag{16}$$

$$\nu = c/\lambda \tag{17}$$

where

$$h = \text{Plancks Const.} = 6.626 \times 10^{-34} \text{ joules-sec} \tag{18}$$

$$\xi = hc\, \eta/2\lambda \tag{19}$$

$$c = \text{speed of light in vacuo} = 2.998 \times 10^8 \text{ m/sec} \tag{20}$$

$$hc = 1.9863 \times 10^{-25} \tag{21}$$

Hence

$$\xi \cong 1.99 \times 10^{-25}\, (\eta/2)(1/\lambda) \text{ joules/m}^2 \tag{22}$$

λ = for UV light will be taken as a mean value of $3500\text{Å} = 3500 \times 10^{-10}$m, or $\lambda = 3.5 \times 10^{-7}$m (23)

Hence from (20) the photon energy of 3500Å wavelength to photoionize $\eta/2$ electrons per m^2 is:

$$\xi = (\eta/2) \times 5.69 \times 10^{-19} \text{ joules/m}^2 \tag{24}$$

Using result (15) in (22):

$$\xi = 3.97 \times 10^{-4} \text{ joules/m}^2 \tag{25}$$

Assume this energy is developed in 1 second, then the power density of ultraviolet light which must be delivered is:

$$\rho \cong 4 \times 10^{-4} \text{ watts/m}^2 \text{ (1 sec)} \tag{26}$$

By comparison, on a bright sunny day a surface of 1 cm^2 at right angles to the sun receives an average of 1 gm cal of radiant energy per min. This is equivalent to 700 $watts/m^2$ of radiant energy.

If 6% of this radiation is UV, then there is

$$40 \text{ watts/m}^2 \tag{27}$$

of UV radiant sun energy.

Comparing (26) and (27) the sun's UV light would produce sufficient photoions to fully shield the dipole in a time:

$$t = 4 \times 10^{-4}/40 = 10^{-5} \text{ sec} \tag{28}$$

There are, of course, more powerful UV sources available than that from normal sunlight which would produce the requisite shielding in a shorter time.

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